

## SELF-TEST

## A. Multiple Choice:

1. Which of the following will make a solution basic?

(1) NaCl      (2)  $\text{Na}_3\text{PO}_4$       (3)  $\text{NH}_3$       (4)  $\text{NH}_4\text{Cl}$       (5) HCN      (6) KCN

a. (1),(2),(3)      b. (2),(3),(4)      c. (2),(3),(6)      d. (3),(4),(6)

2. When  $1 \times 10^{-5}$  mole of NaOH is added to enough water to make 1.0 L of solution, the resulting solution has a pH of

a. 5      b. 6      c. 7      d. 8      e. 9

3. Vinegar generally contains 5% acetic acid. We would expect the pH of vinegar to be approximately

a. 0      b. 3      c. 7      d. 9      e. 12

4. Which pair below consists of a Bronsted acid and a Bronsted base?

a. HI,  $\text{NH}_4^+$       b.  $\text{SO}_3^-$ ,  $\text{H}_2\text{PO}_4^-$       c.  $\text{NH}_3$ ,  $\text{PO}_4^{3-}$       d.  $\text{H}_2\text{CO}_3$ ,  $\text{H}_3\text{O}^+$

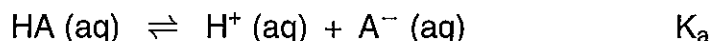
5. As the hydrogen ion concentration decreases in an aqueous solution

- hydroxide ion concentration increases.
- pH increases.
- the solution becomes less acidic.
- $K_w$  increases.

The number of correct choices is

a. 0      b. 1      c. 2      d. 3      e. 4

6. For the acetic acid/acetate ion system, the following ionization constants are defined:



The true expressions are

(1)  $K_a + K_b = 1$       (2)  $K_a \times K_b = K_w$       (3)  $K_a/K_b = 1$       (4)  $K_a + K_b = K_w$

a. (1)      b. (1),(2)      c. (3),(4)      d. (2)      e. none of these

7. The pH of a 0.1 M solution of  $\text{H}_2\text{SO}_4$  is

a. between 0 and 1      b. 1      c. between 1 and 2  
d. 2      e. None of those

8. Consider solutions of the following salts

(1)  $\text{CsClO}_4$       (2)  $\text{Cr}(\text{NO}_3)_3$       (3)  $\text{CH}_3\text{NH}_2$

Listed in order of increasing pH, the correct order is

a. (1),(2),(3)      b. (2),(1),(3)      c. (1),(3),(2)      d. (3),(2),(1)

9. Given the following  $K_a$  values

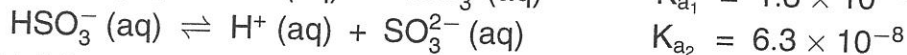
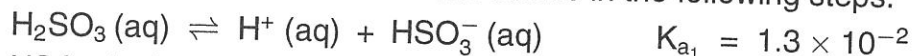
$\text{HC}_2\text{H}_3\text{O}_2$	$1.8 \times 10^{-5}$
$\text{HCN}$	$5.8 \times 10^{-10}$
$\text{HOCl}$	$2.8 \times 10^{-8}$

$\text{HBrO}$	$5.8 \times 10^{-10}$
$\text{HF}$	$6.9 \times 10^{-4}$

Which of the following is the weakest base?

- a.  $\text{C}_2\text{H}_3\text{O}_2^-$       b.  $\text{BrO}^-$       c.  $\text{CN}^-$       d.  $\text{F}^-$       e.  $\text{OCl}^-$

10. Sulfurous acid is a diprotic acid. Its ionization occurs in the following steps:



In a 0.10 M  $\text{H}_2\text{SO}_3$  solution whose pH has been adjusted to 10, which of the following species would have the highest concentration?

- a.  $\text{SO}_3^{2-}$       b.  $\text{HSO}_3^-$       c.  $\text{H}^+$       d.  $\text{H}_2\text{SO}_3$       e.  $\text{H}_2\text{O}$

### B. Fill in the Blanks

Consider aqueous solutions of the following salts. On the space provided, write **A** if the solution is *acidic*, **B** if the solution is *basic* or **N** if the solution is *neutral*.

\_\_\_\_\_ 1.  $\text{FeCl}_3$

\_\_\_\_\_ 2.  $\text{NaI}$  and  $\text{KNO}_3$

\_\_\_\_\_ 3.  $\text{Mg}(\text{OH})_2$  and  $\text{CaCO}_3$

\_\_\_\_\_ 4.  $\text{CsClO}_4$  and  $\text{KNO}_2$

\_\_\_\_\_ 5.  $\text{NH}_4\text{Br}$  and  $\text{KBr}$

### C. Problems:

Consider two solutions. One solution is 0.1385 M  $\text{Ba}(\text{OH})_2$ . The other is 0.2050 M  $\text{HBr}$ .

1. Calculate the pH of the  $\text{HBr}$  solution.

2. Calculate the pH of the  $\text{Ba}(\text{OH})_2$  solution.

3. If 50.00 mL of the  $\text{Ba}(\text{OH})_2$  is mixed with 30.00 mL of the HBr solution, what is the pH of the resulting solution?

Consider propionic acid,  $\text{HC}_3\text{H}_5\text{O}_2$ .

4. Write a balanced equation for the reaction that takes place when it is dissolved in water.
5. Write the  $K_a$  expression for this reaction.
6. Calculate  $K_a$  for propionic acid if a 500.0-mL solution of propionic acid containing 9.250 g of the acid has a pH of 2.73.
7. A different solution of propionic acid is prepared by dissolving 1.5000 g in enough water to make 2.000 L of solution. Using the  $K_a$  calculated in (6), what is the pH of the resulting solution?

8. Is sodium propionate,  $\text{NaC}_3\text{H}_5\text{O}_2$  acidic, basic, or neutral? Write an equation to prove your answer.
9. Calculate  $K_b$  for  $\text{C}_3\text{H}_5\text{O}_2^-$ .
10. A 750.0-ml solution contains 20.00 g of  $\text{NaC}_3\text{H}_5\text{O}_2$ . What is the pH of this solution?

**ANSWERS****Exercises:**

- (E1)  $2.5 \times 10^{-7}$ ; slightly acidic (E2) 11.899  
(E3) 0.017 M (E4) 0.65 L  
(E5) (1)  $\text{HNO}_2(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{NO}_2^-(\text{aq})$   
(2)  $\text{HNO}_2(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{NO}_2^-(\text{aq})$   
(3)  $\text{NO}_2^-$  is the conjugate base.  
(4)  $K_a = \frac{[\text{H}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$   
(E6)  $5.15 \times 10^{-4}$  (E7)  $5.83 \times 10^{-5}$   
(E8)  $6.9 \times 10^{-5} \text{ M}$   
(E9)  $\text{H}_2\text{CO}_3(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$ ;  $\text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq})$   
(E10)  $[\text{OH}^-] = 6.3 \times 10^{-3}$ ; pH = 11.80  
(E11) acidic, neutral, acidic, basic, basic (E12) 8.22

**Self-Test****A. Multiple Choice:**

- |      |      |      |      |       |
|------|------|------|------|-------|
| 1. c | 2. e | 3. b | 4. b | 5. d  |
| 6. d | 7. a | 8. b | 9. d | 10. a |

**B. Fill in the blanks**

- |      |      |      |      |      |
|------|------|------|------|------|
| 1. A | 2. N | 3. B | 4. B | 5. A |
|------|------|------|------|------|

**C. Problems:**

1. 0.6882

2. 13.44

3. 12.98

4.  $\text{HC}_3\text{H}_5\text{O}_2 (\text{aq}) \rightleftharpoons \text{H}^+ (\text{aq}) + \text{C}_3\text{H}_5\text{O}_2^- (\text{aq})$ 5.  $K_a = \frac{[\text{H}^+][\text{C}_3\text{H}_5\text{O}_2^-]}{[\text{HC}_3\text{H}_5\text{O}_2]}$ 6.  $1.4 \times 10^{-5}$ 

7. 3.42

8. basic;  $\text{C}_3\text{H}_5\text{O}_2^- (\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{HC}_3\text{H}_5\text{O}_2 (\text{aq}) + \text{OH}^- (\text{aq})$ 9.  $7.1 \times 10^{-10}$ 

10. 9.15